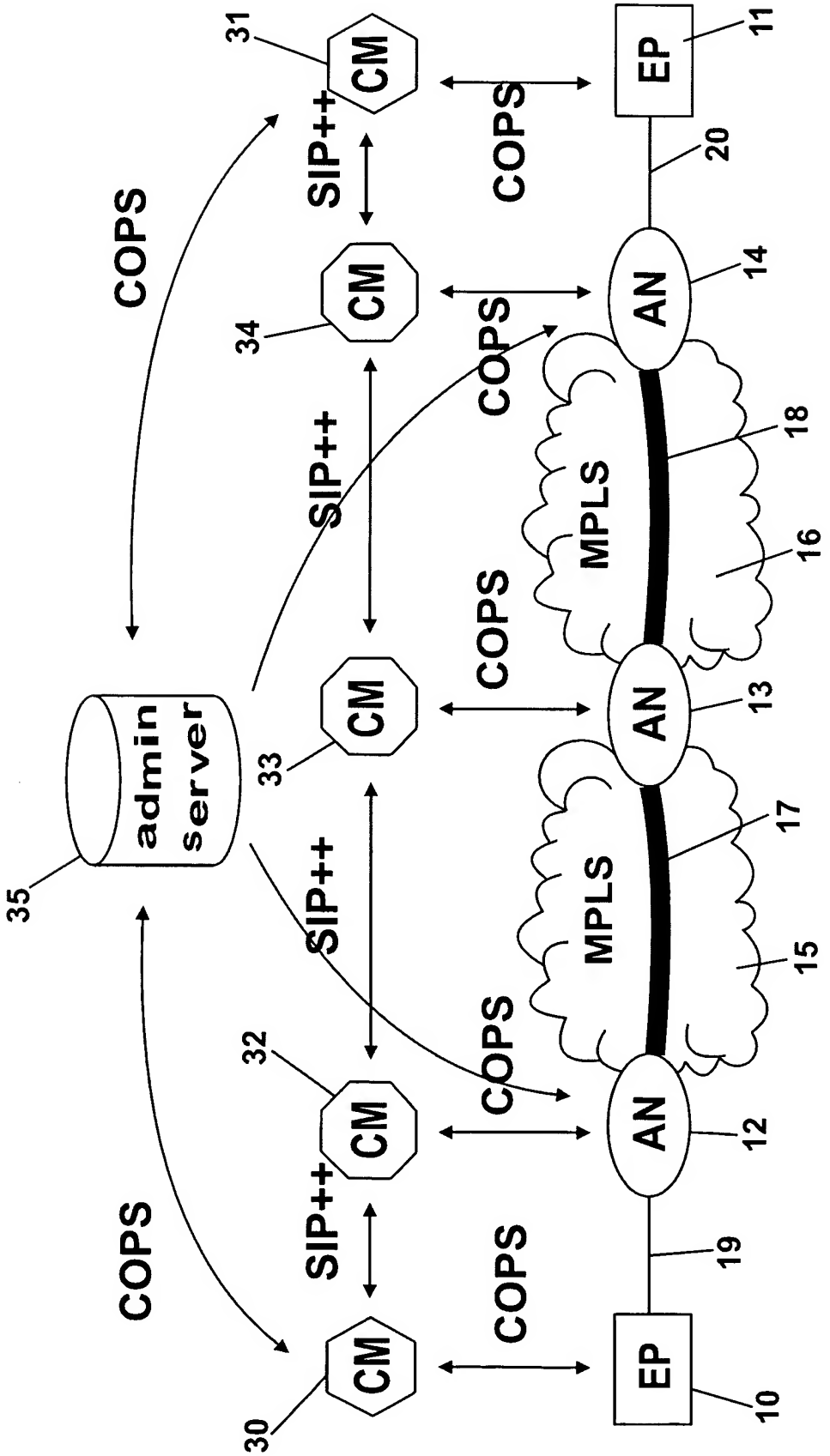
admin server
35
COPS
SIP++
CM
30
31
32
33
34
AN
12
13
14
EP
10
11
MPLS
15
16
17
18
19
20

Fig. 1

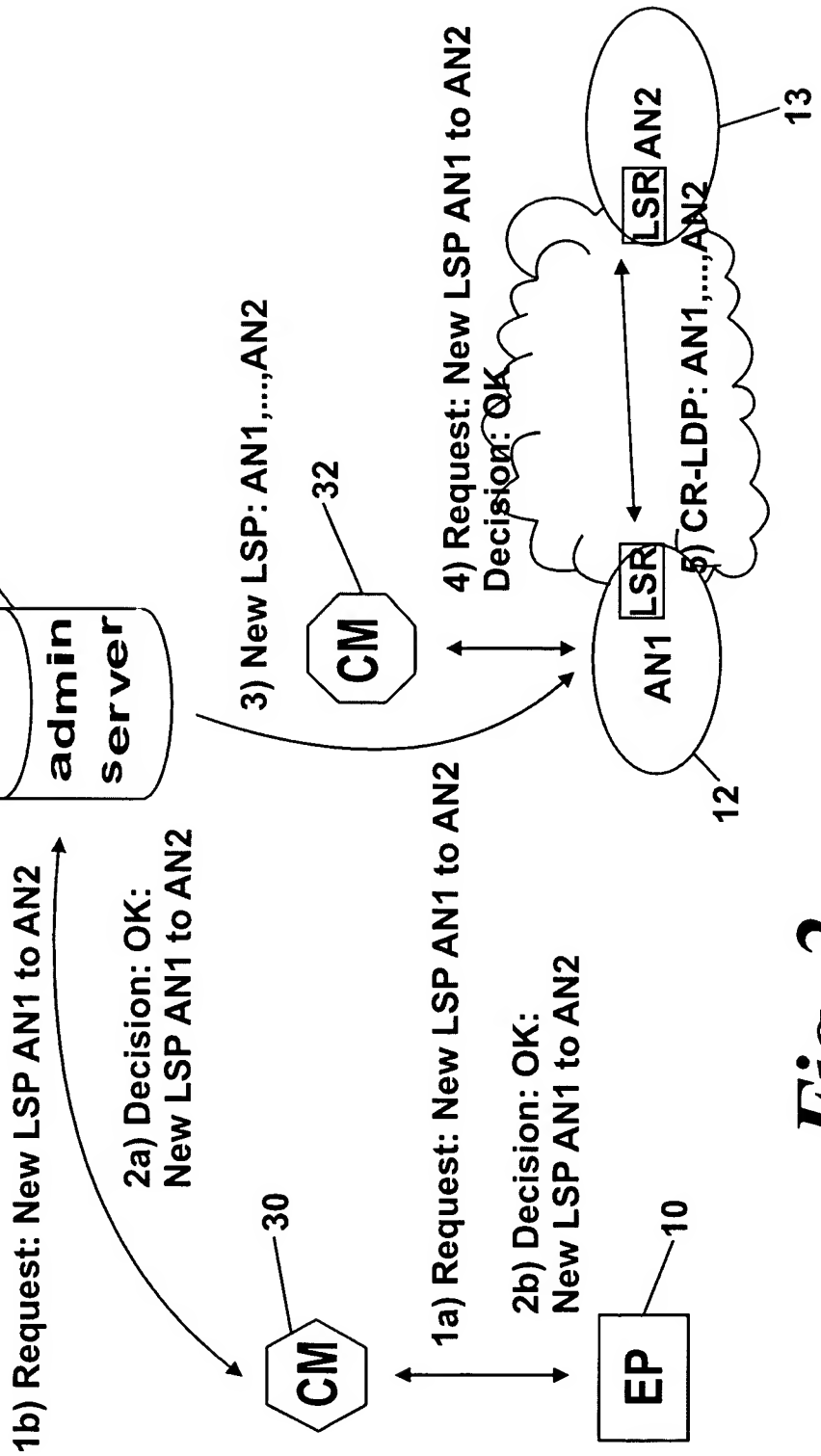
35
admin server
32
CM
3) New LSP: AN1,...,AN2
4) Request: New LSP AN1 to AN2
Decision: OK
LSR
AN2
5) CR-LDP: AN1,...,AN2
LSR
AN1
13
12
1b) Request: New LSP AN1 to AN2
2a) Decision: OK:
New LSP AN1 to AN2
30
CM
1a) Request: New LSP AN1 to AN2
2b) Decision: OK:
New LSP AN1 to AN2
10
EP

Fig. 2

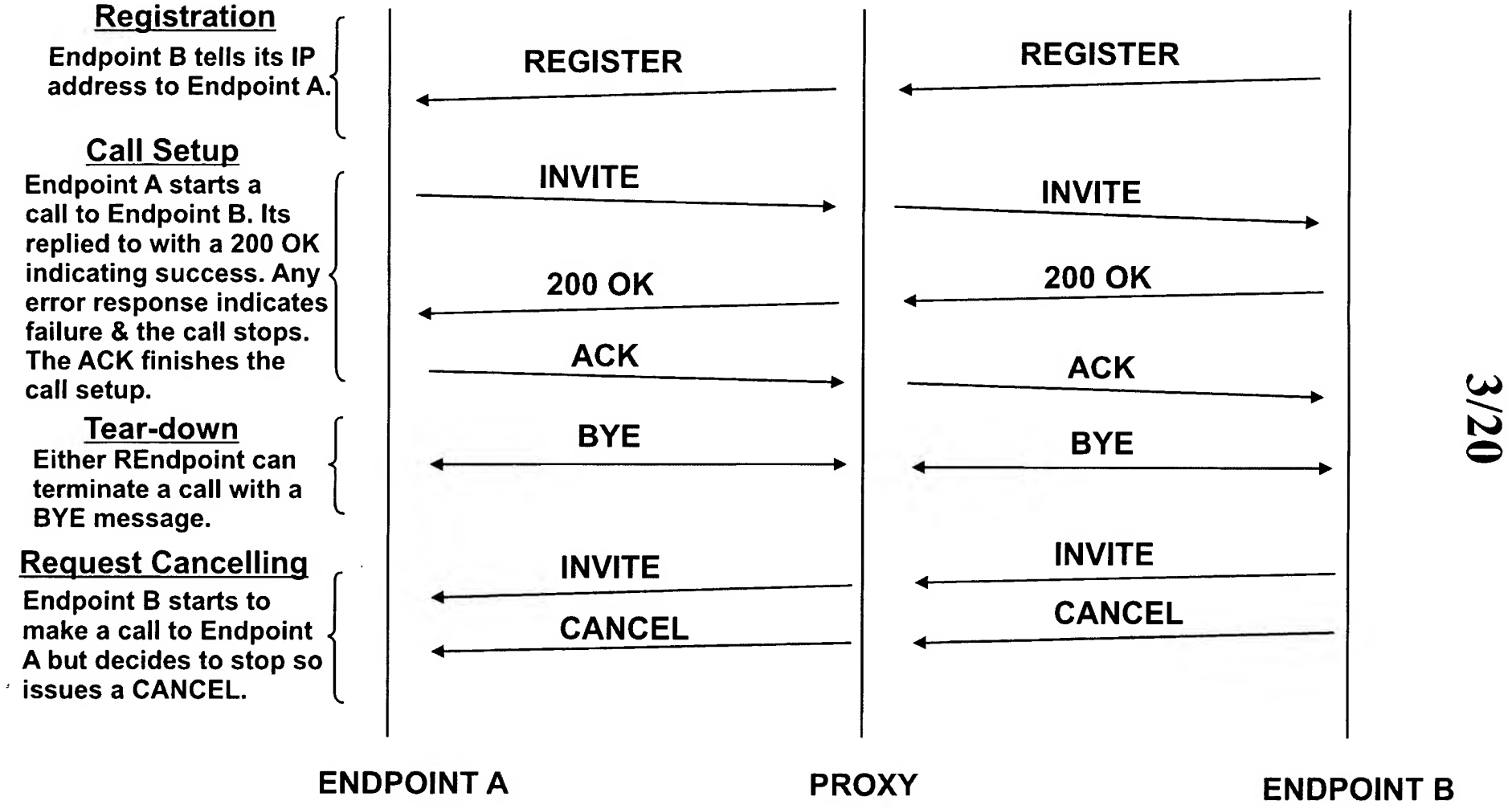
Registration
Endpoint B tells its IP address to Endpoint A.
Call Setup
Endpoint A starts a call to Endpoint B. Its replied to with a 200 OK indicating success. Any error response indicates failure & the call stops. The ACK finishes the call setup.
Tear-down
Either REndpoint can terminate a call with a BYE message.
Request Cancelling
Endpoint B starts to make a call to Endpoint A but decides to stop so issues a CANCEL.
REGISTER
REGISTER
INVITE
INVITE
200 OK
200 OK
ACK
ACK
BYE
BYE
INVITE
INVITE
CANCEL
CANCEL
ENDPOINT A
PROXY
ENDPOINT B

Fig. 3

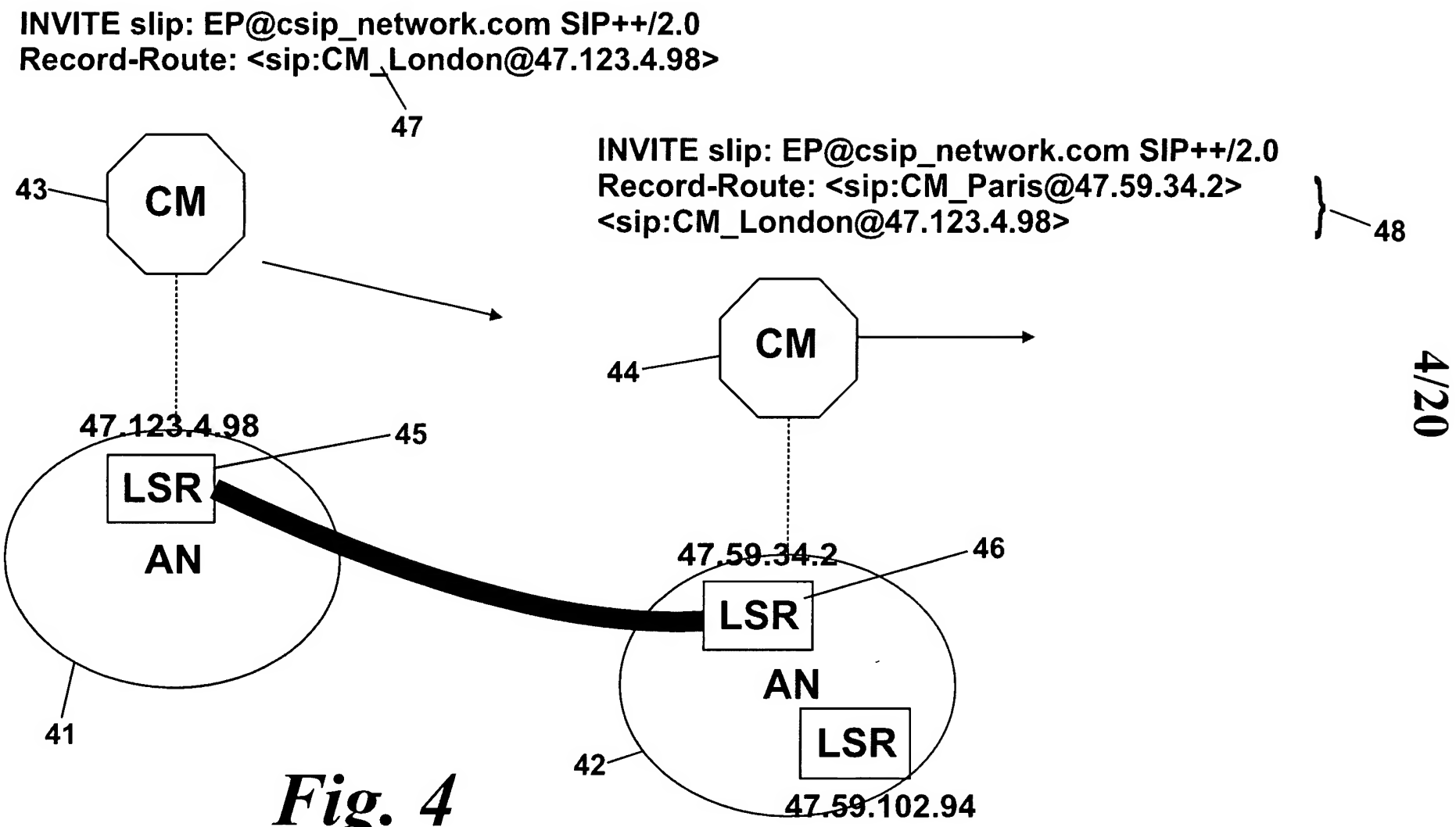
INVITE slip: EP@csip_network.com SIP++/2.0
Record-Route: <sip:CM_London@47.123.4.98>
47
43
CM
INVITE slip: EP@csip_network.com SIP++/2.0
Record-Route: <sip:CM_Paris@47.59.34.2>
<sip:CM_London@47.123.4.98>
48
CM
44
47.123.4.98
45
LSR
AN
41
47.59.34.2
46
LSR
AN
LSR
42
47.59.102.94

Fig. 4

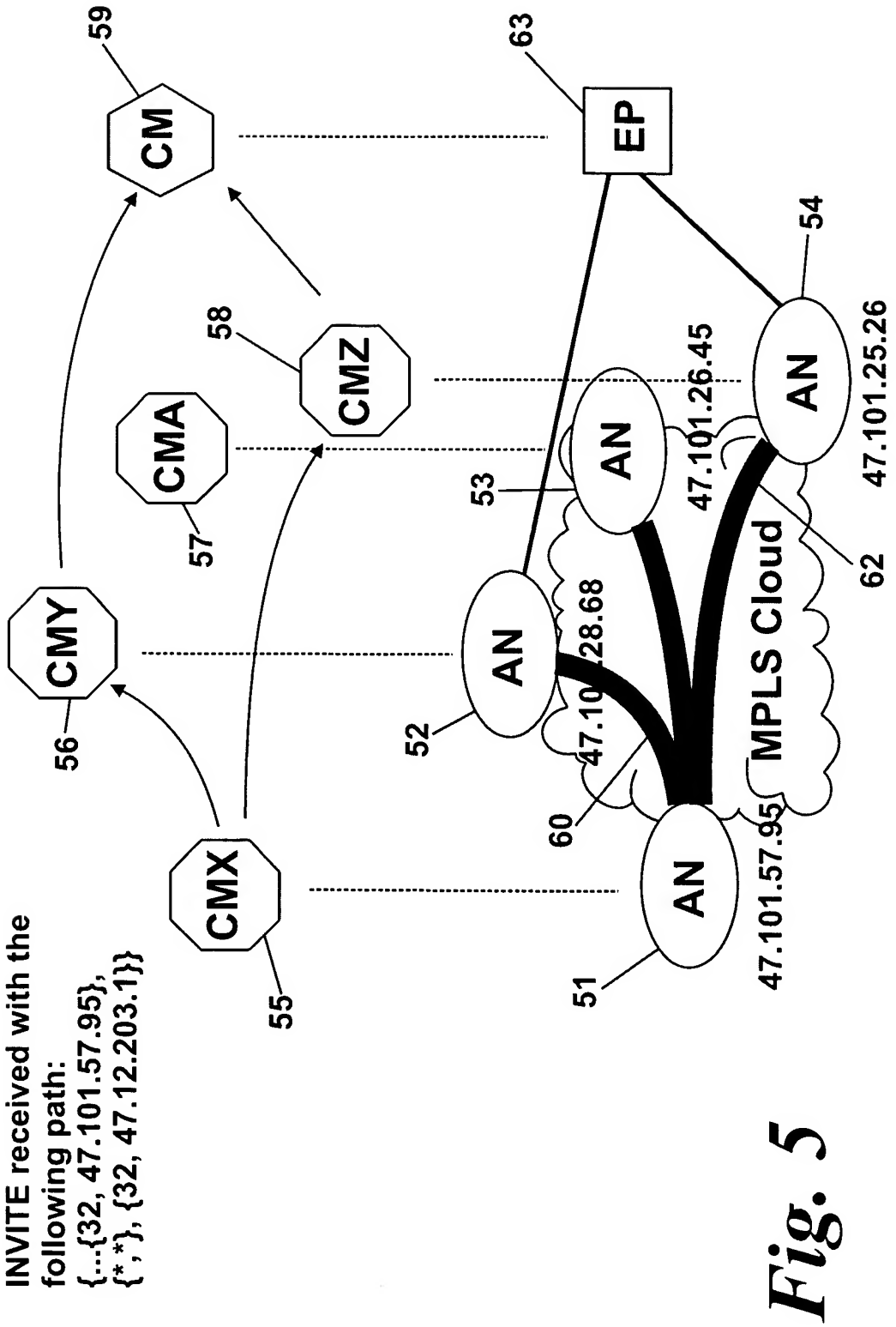
INVITE received with the following path:
{...{32, 47.101.57.95},
{*,*}, {32, 47.12.203.1}}
CM
CMY
CMA
CMZ
CMX
EP
AN
AN
AN
AN
MPLS Cloud
47.101.57.95
47.101.25.26
47.101.26.45
47.10 28.68
59
56
57
58
55
63
54
53
52
60
62
51

Fig. 5

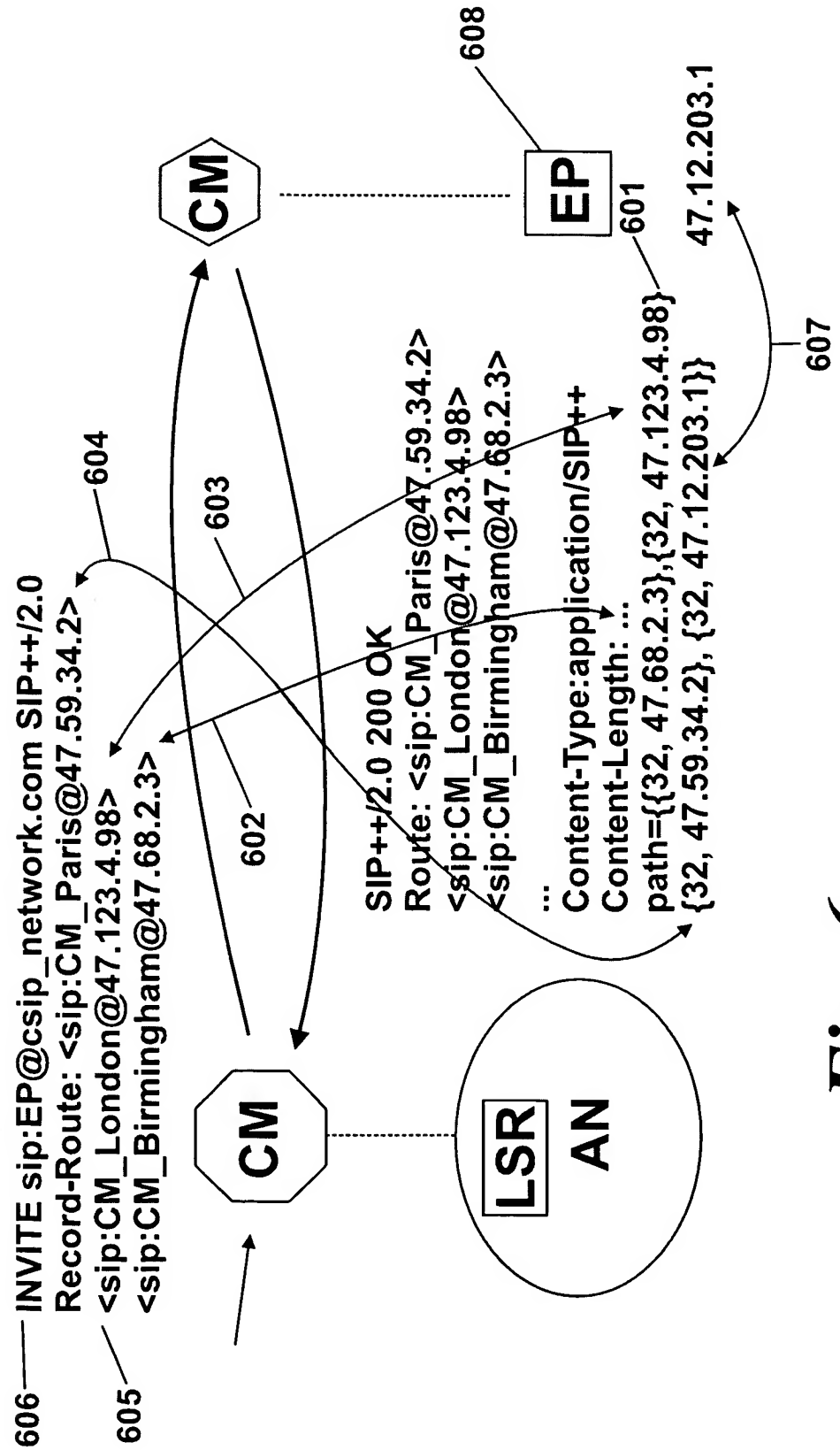
606
INVITE sip:EP@csip_network.com SIP++/2.0
Record-Route: <sip:CM_Paris@47.59.34.2>
<sip:CM_London@47.123.4.98>
<sip:CM_Birmingham@47.68.2.3>
605
604
603
602
CM
CM
LSR
AN
608
EP
601
SIP++/2.0 200 OK
Route: <sip:CM_Paris@47.59.34.2>
<sip:CM_London@47.123.4.98>
<sip:CM_Birmingham@47.68.2.3>
...
Content-Type:application/SIP++
Content-Length: ...
path={{32, 47.68.2.3},{32, 47.123.4.98}
{32, 47.59.34.2}, {32, 47.12.203.1}}
47.12.203.1
607

Fig. 6

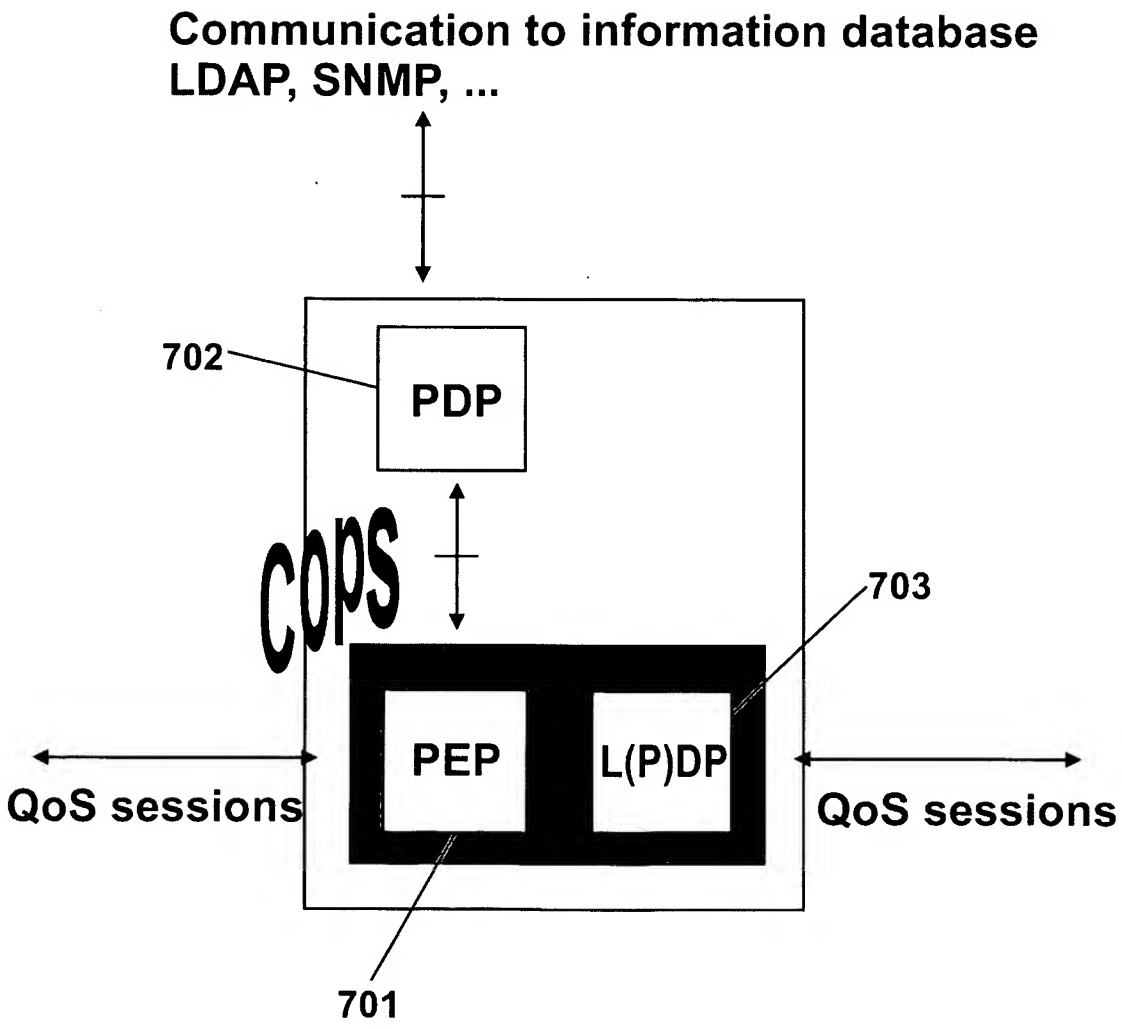
Communication to information database
LDAP, SNMP, ...
702
PDP
COPS
703
PEP
L(P)DP
QoS sessions
QoS sessions
701

Fig. 7

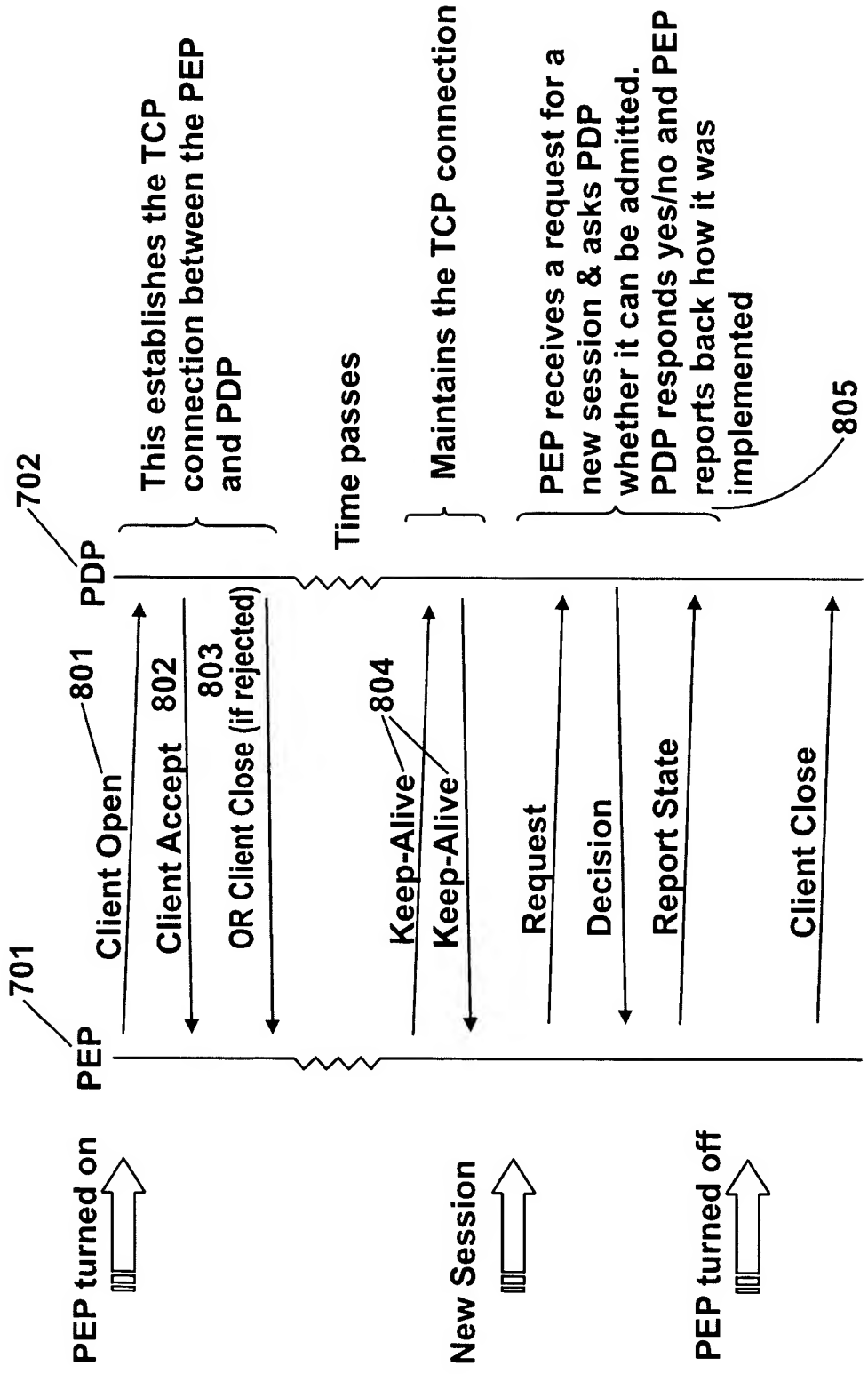
PEP turned on
New Session
PEP turned off
701
PEP
702
PDP
801
Client Open
802
Client Accept
803
OR Client Close (if rejected)
804
Keep-Alive
Keep-Alive
Request
Decision
Report State
Client Close
805
Time passes
This establishes the TCP connection between the PEP and PDP
Maintains the TCP connection
PEP receives a request for a new session & asks PDP whether it can be admitted. PDP responds yes/no and PEP reports back how it was implemented

Fig. 8

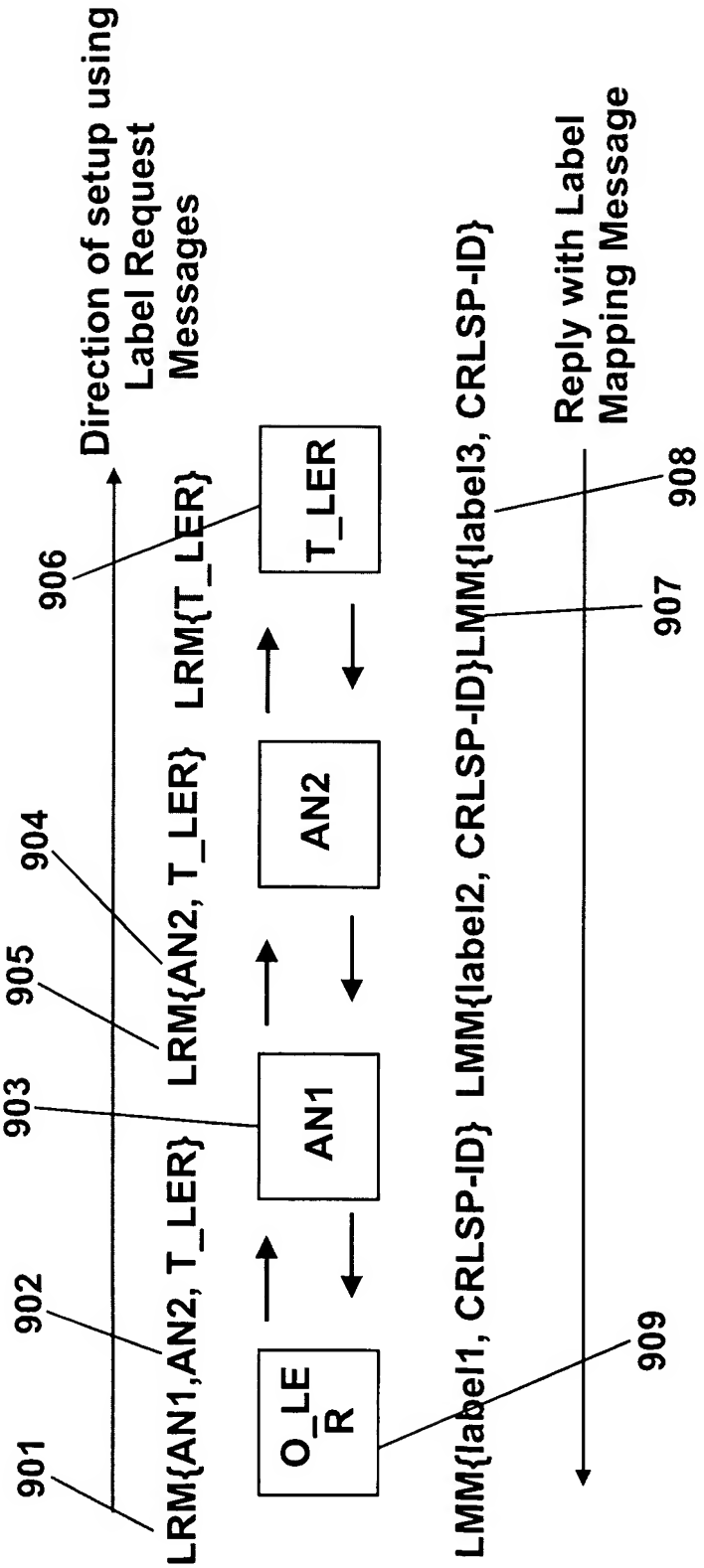
Direction of setup using Label Request Messages
LRM{AN1,AN2, T_LER}
LRM{AN2, T_LER}
LRM{T_LER}
LMM{label1, CRLSP-ID}
LMM{label2, CRLSP-ID}
LMM{label3, CRLSP-ID}
Reply with Label Mapping Message
O_LER
AN1
AN2
T_LER
901
902
903
904
905
906
907
908
909

Fig. 9

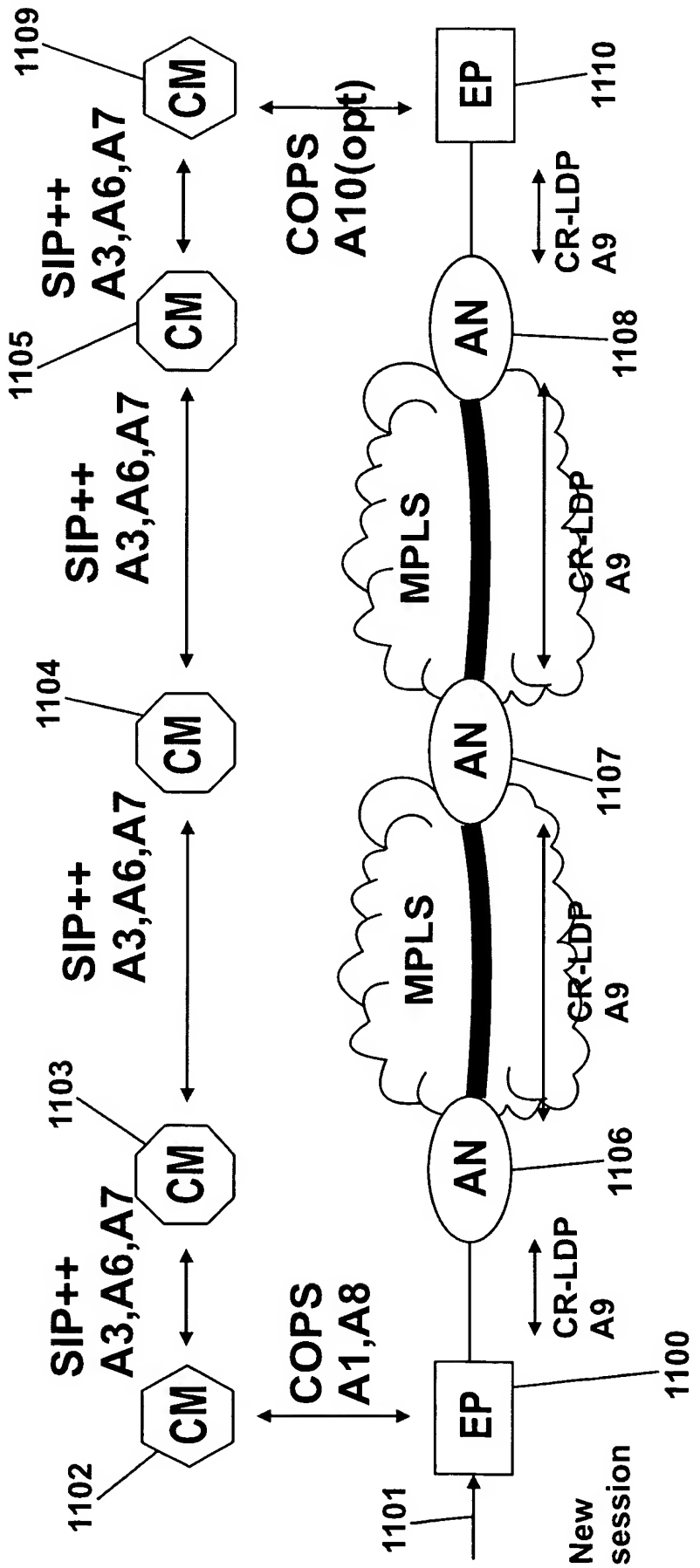
1102
CM
SIP++
A3,A6,A7
1103
CM
SIP++
A3,A6,A7
1104
CM
SIP++
A3,A6,A7
1105
CM
SIP++
A3,A6,A7
1109
CM
COPS
A1,A8
COPS
A10(opt)
1101
EP
1100
EP
1110
New
session
CR-LDP
A9
AN
1106
MPLS
CR-LDP
A9
AN
1107
MPLS
CR-LDP
A9
AN
1108
CR-LDP
A9

Fig. 10

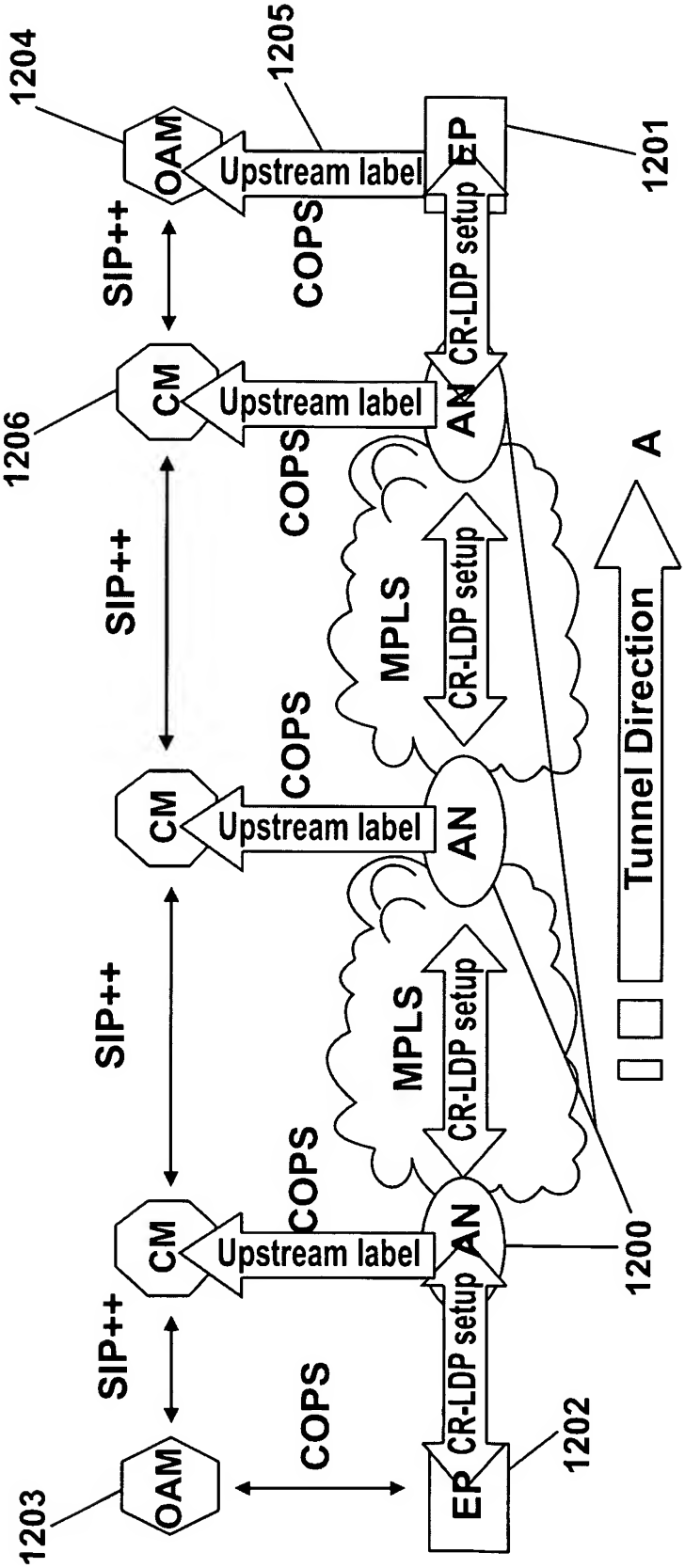
1204
1205
1201
OAM
Upstream label
EP
SIP++
COPS
CR-LDP setup
CM
Upstream label
AN
1206
COPS
SIP++
MPLS
CR-LDP setup
A
CM
COPS
Upstream label
AN
Tunnel Direction
SIP++
MPLS
CR-LDP setup
CM
COPS
Upstream label
AN
1200
SIP++
COPS
CR-LDP setup
OAM
ER
1202
1203

Fig. 11

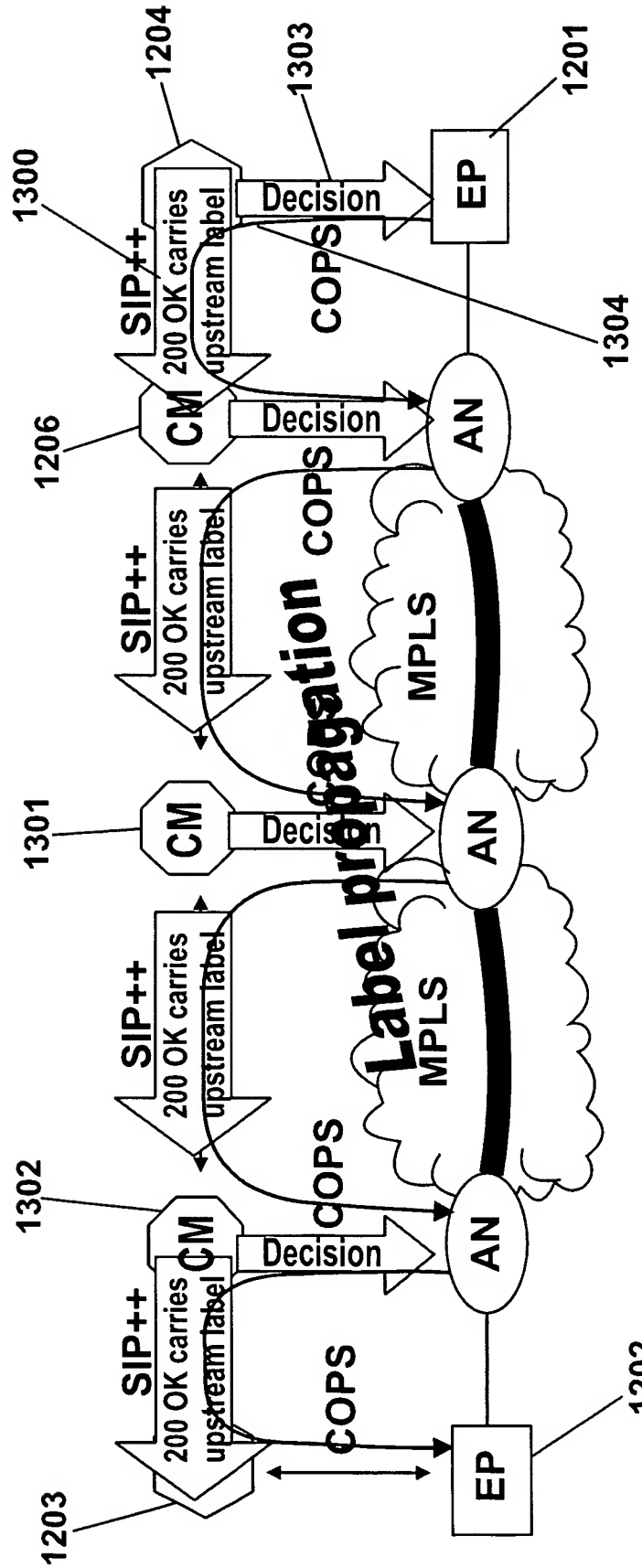
1204
1303
1201
1300
SIP++
200 OK carries upstream label
Decision
EP
COPS
1304
1206
CM
Decision
AN
SIP++
200 OK carries upstream label
COPS
Label propagation
MPLS
1301
CM
Decision
AN
SIP++
200 OK carries upstream label
COPS
MPLS
1302
CM
Decision
AN
SIP++
200 OK carries upstream label
COPS
1202
1203
EP

Fig. 12

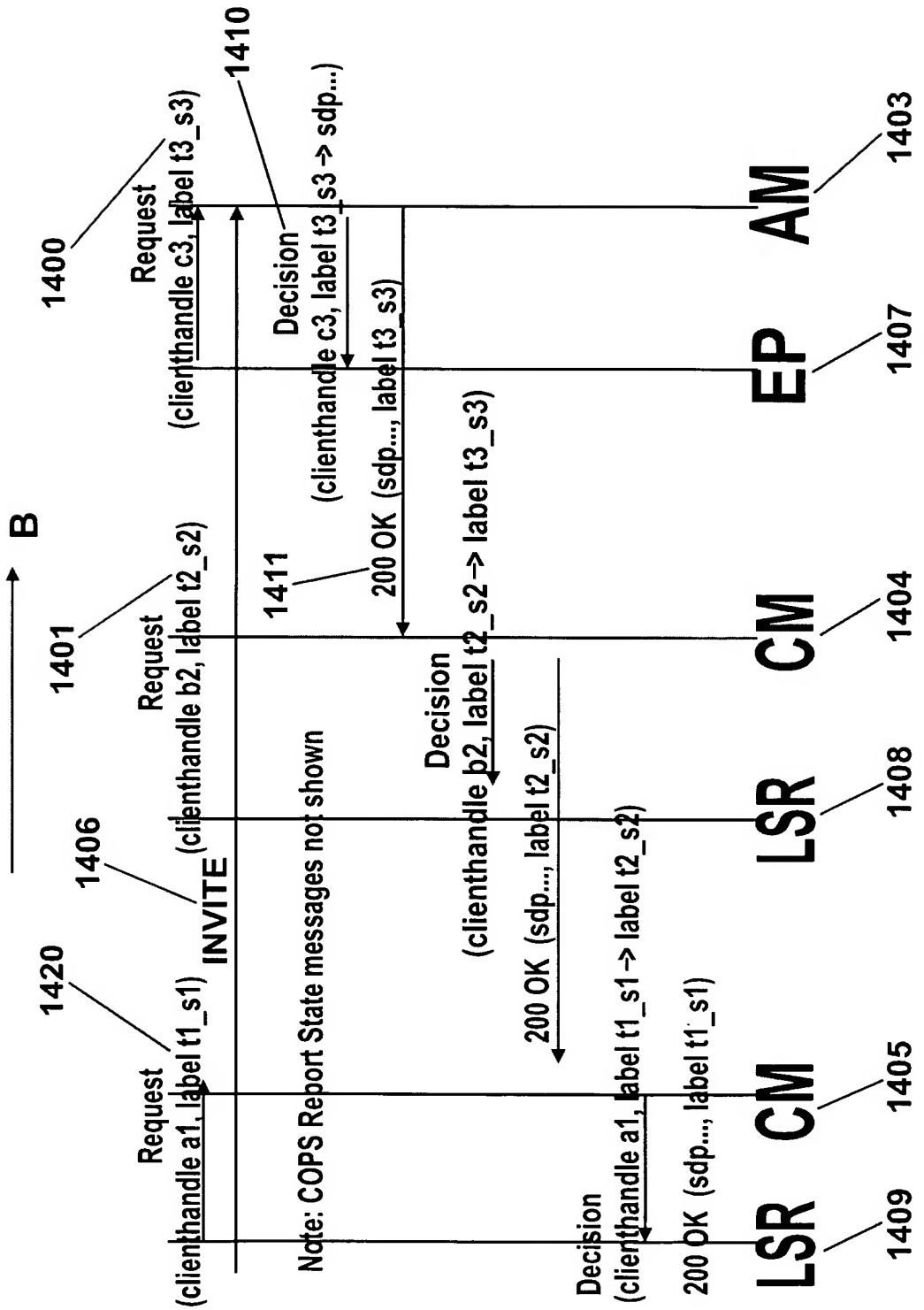
B
LSR
CM
LSR
CM
EP
AM
1409
1405
1408
1404
1407
1403
1420
1406
1401
1411
1410
1400
Request
(clienthandle a1, label t1_s1)
INVITE
Note: COPS Report State messages not shown
Request
(clienthandle b2, label t2_s2)
200 OK (sdp..., label t1_s1)
Decision
(clienthandle a1, label t1_s1 -> label t2_s2)
200 OK (sdp..., label t2_s2)
Decision
(clienthandle b2, label t2_s2 -> label t3_s3)
200 OK (sdp..., label t3_s3)
Decision
(clienthandle c3, label t3_s3 -> sdp...)
Request
(clienthandle c3, label t3_s3)

Fig. 13

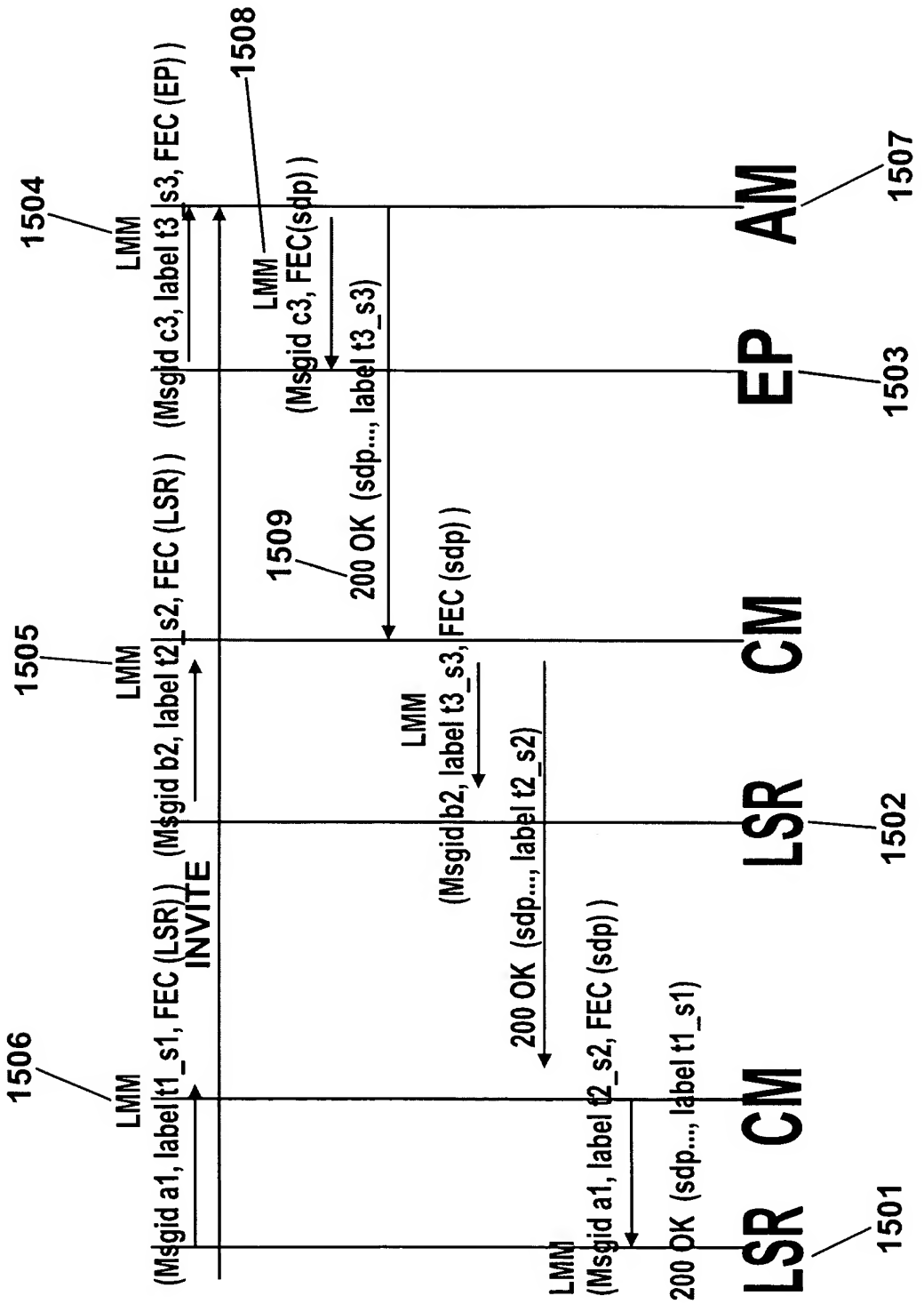
LSR CM
1501
LSR
1502
EP
1503
AM
1507
1504
1505
1506
1508
1509
LMM
(Msgid a1, label t1_s1, FEC (LSR))
INVITE
(Msgid b2, label t2_s2, FEC (LSR))
(Msgid c3, label t3_s3, FEC (EP))
200 OK (sdp..., label t1_s1)
LMM
(Msgid a1, label t2_s2, FEC (sdp))
200 OK (sdp..., label t2_s2)
LMM
(Msgid b2, label t3_s3, FEC (sdp))
200 OK (sdp..., label t3_s3)
LMM
(Msgid c3, FEC(sdp))

Fig. 14

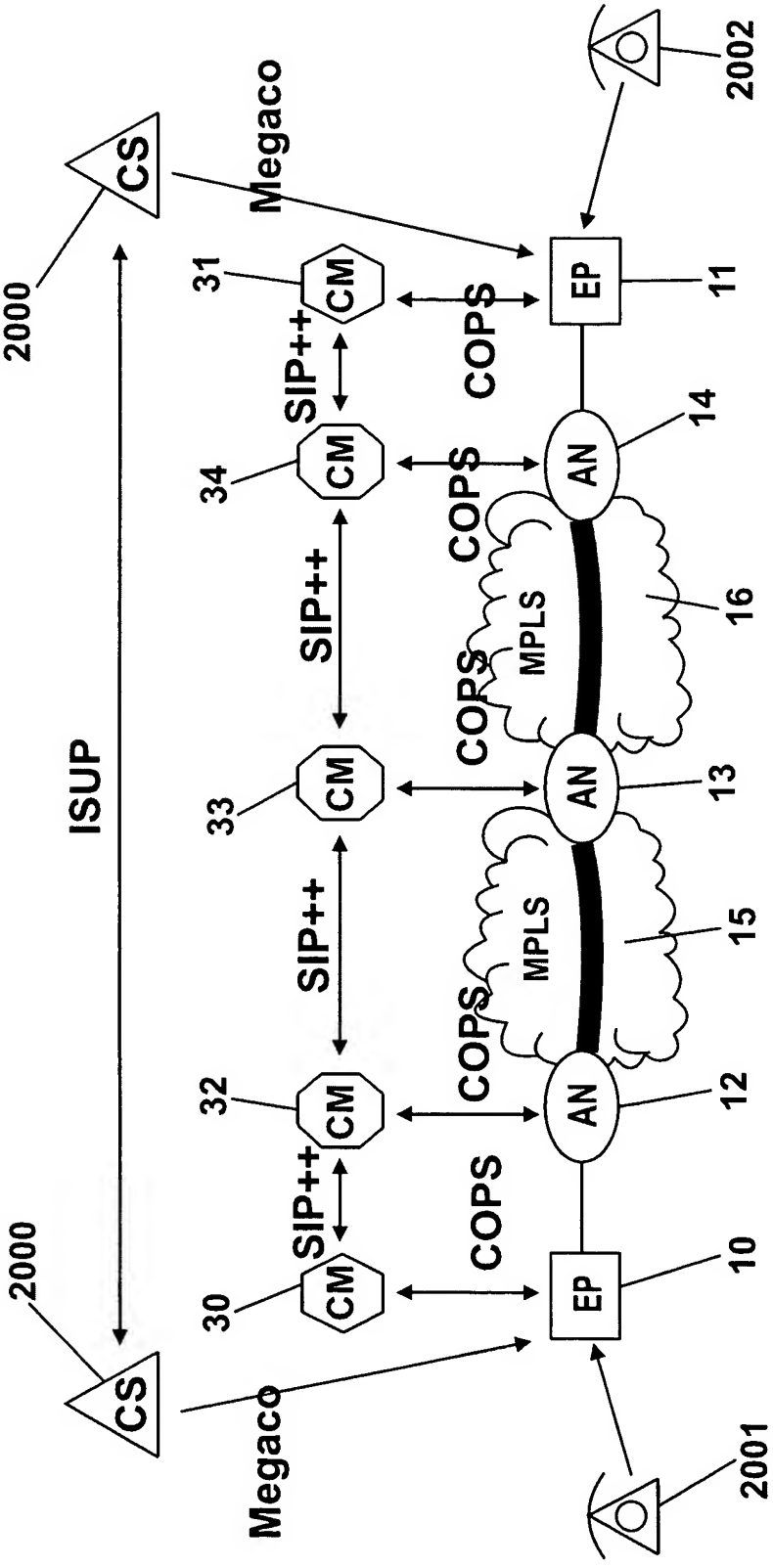
2000
CS
ISUP
2000
CS
Megaco
Megaco
2001
2002
EP
10
EP
11
AN
12
AN
13
AN
14
MPLS
15
MPLS
16
CM
30
CM
31
CM
32
CM
33
CM
34
SIP++
SIP++
SIP++
SIP++
COPS
COPS
COPS
COPS
COPS
COPS

Fig. 15

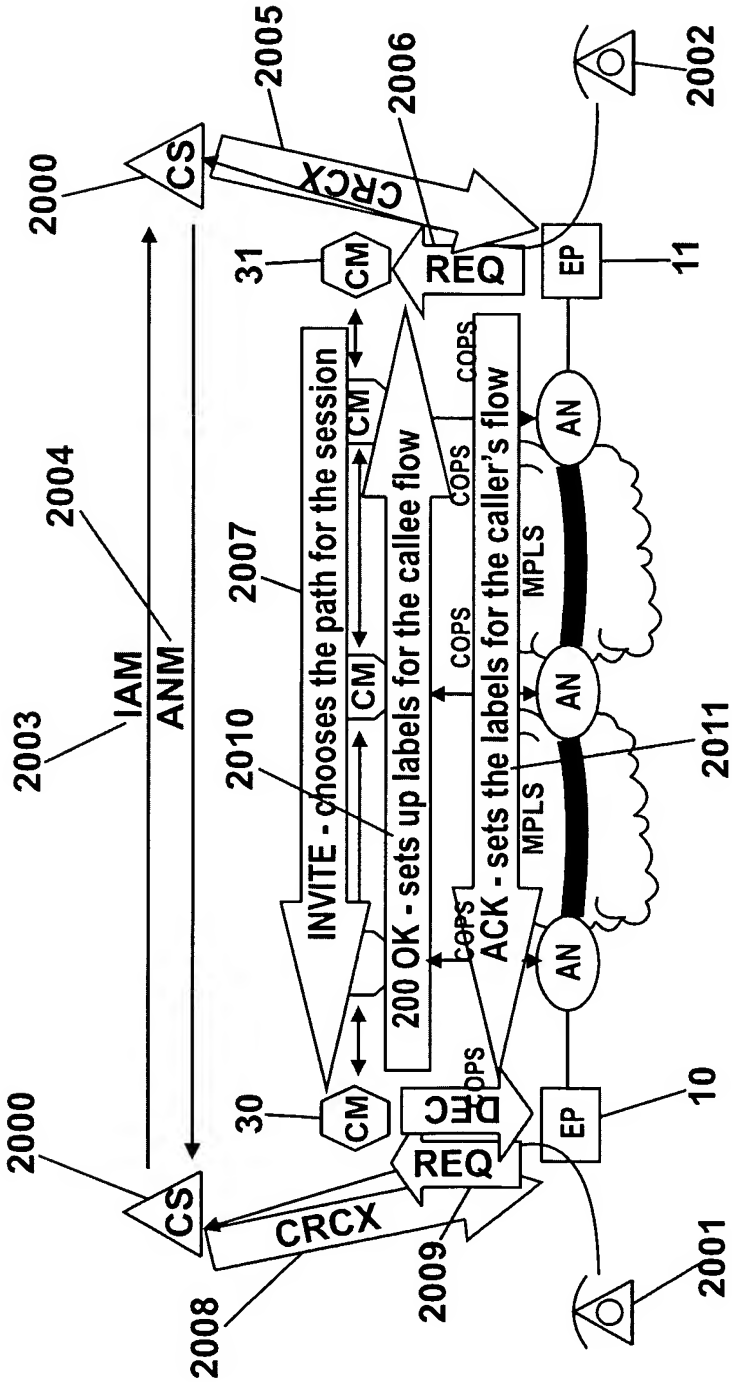
2000
CS
2005
CRCX
2006
2002
31
CM
REQ
EP
11
2004
2007
CM
COPS
AN
2003
IAM
ANM
INVITE - chooses the path for the session
MPLS
2010
200 OK - sets up labels for the callee flow
ACK - sets the labels for the caller's flow
2011
30
REQ
10
2000
CS
CRCX
2008
2009
2001

Fig. 16

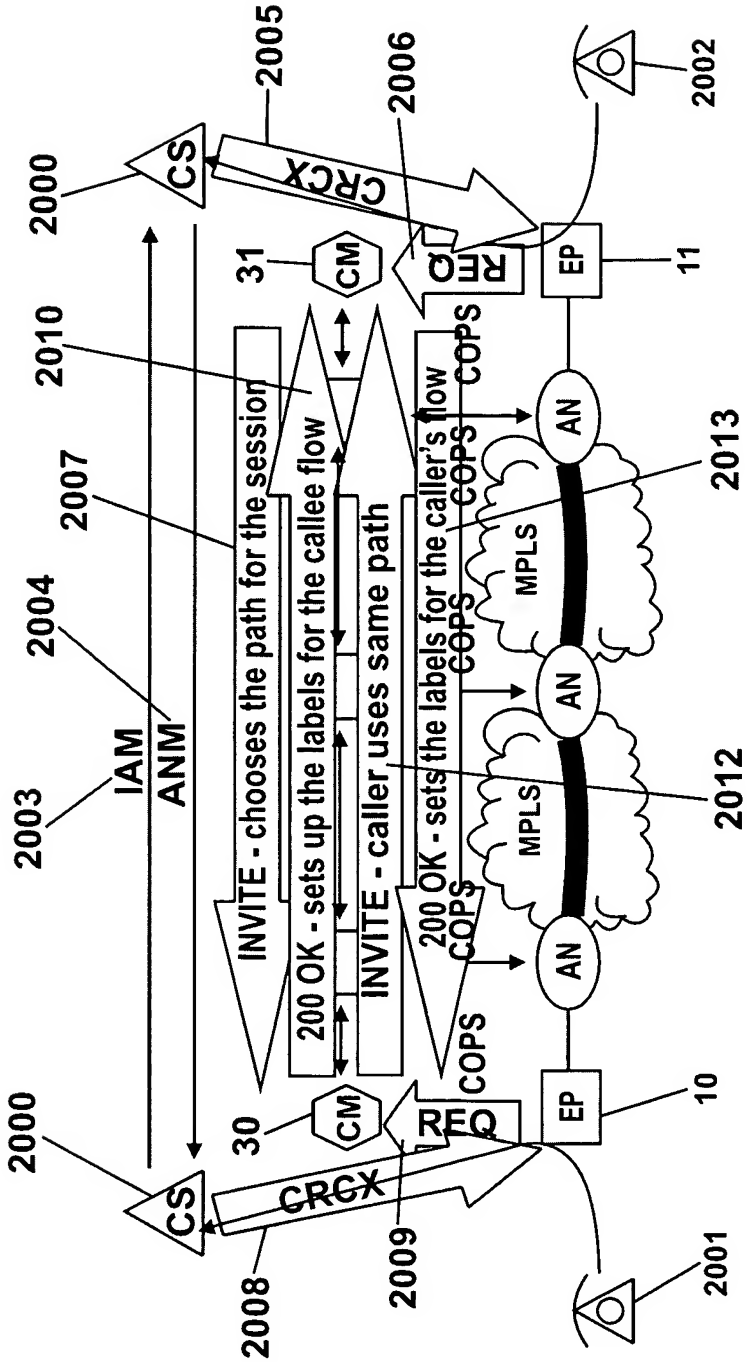
2000
CS
2005
CRCX
2006
2002
31
CM
REQ
EP
11
2010
2007
2004
2003
IAM
ANM
INVITE - chooses the path for the session
200 OK - sets up the labels for the callee flow
INVITE - caller uses same path
200 OK - sets the labels for the caller's flow
COPS
AN
MPLS
2013
2012
30
10
2008
2009
2001

Fig. 17

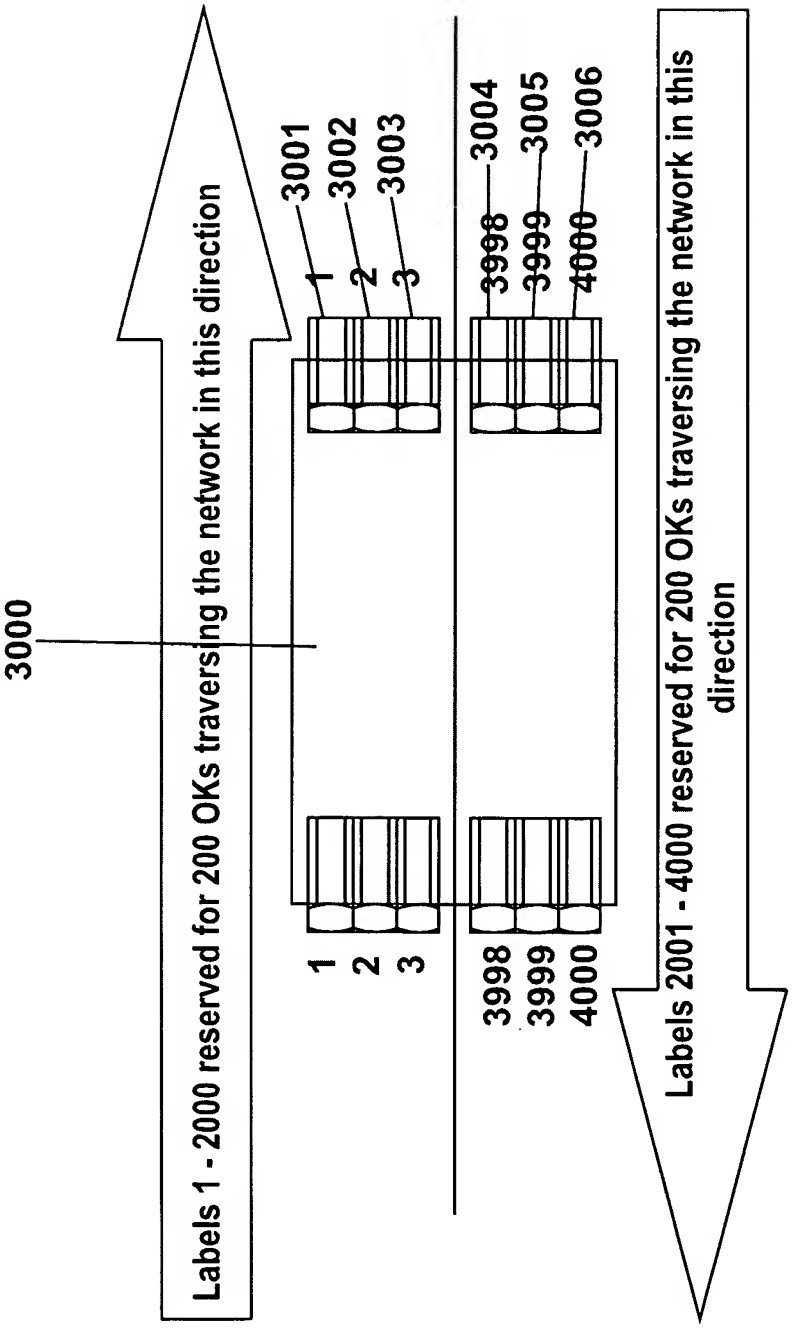
3000
Labels 1 - 2000 reserved for 200 OKs traversing the network in this direction
3001
3002
3003
3004
3005
3006
1
2
3
3998
3999
4000
1
2
3
3998
3999
4000
Labels 2001 - 4000 reserved for 200 OKs traversing the network in this direction

Fig. 18

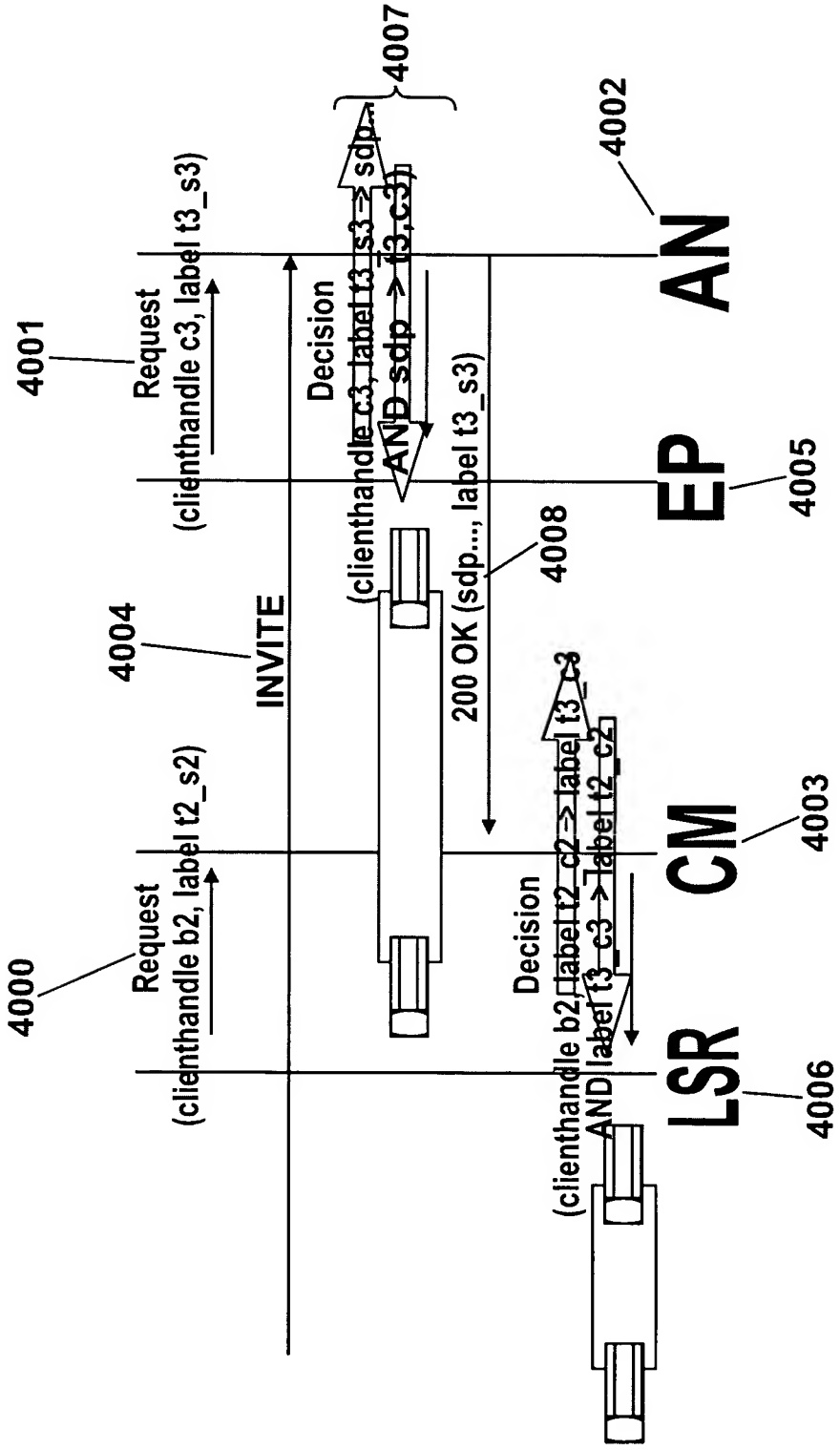
4000
Request
(clienthandle b2, label t2_s2)
4001
Request
(clienthandle c3, label t3_s3)
4002
AN
4003
CM
4004
INVITE
4005
EP
4006
LSR
4007
Decision
(clienthandle c3, label t3_s3 => sdp...
AND sdp -> t3,c3)
4008
200 OK (sdp..., label t3_s3)
Decision
(clienthandle b2, label t2_c2 => label t3_c3
AND label t3_c3 -> label t2_c2)

Fig. 19

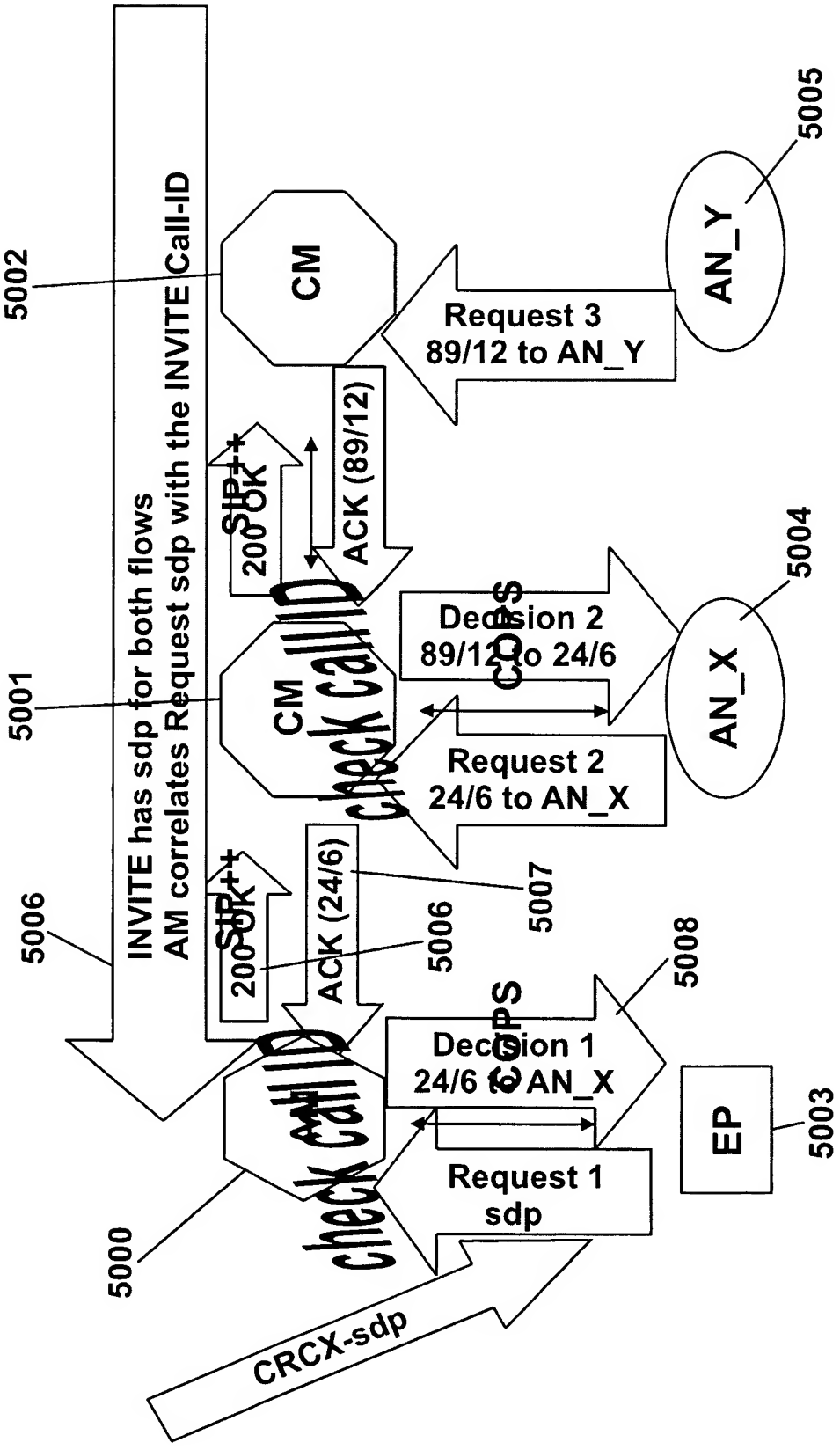
5002
CM
5005
AN_Y
Request 3
89/12 to AN_Y
INVITE has sdp for both flows
AM correlates Request sdp with the INVITE Call-ID
200 OK SIP++
ACK (89/12)
5001
CM
check callID
COPS
Decision 2
89/12 to 24/6
5004
AN_X
Request 2
24/6 to AN_X
5006
200 OK SIP++
ACK (24/6)
5007
5006
5008
check callID
COPS
Decision 1
24/6 to AN_X
EP
5003
Request 1
sdp
5000
CRCX-sdp

Fig. 20